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ABSTRACT

The purpose of this study was to obtain empirical data for the evaluation of a team approach for teaching biology. A sample of 147 sophomore students was divided into six sections; each section was randomly assigned as control or treatment. The team consisted of three instructors. Each member taught a control group for an entire year. After an introductory session of nine weeks, team members began teaching their specialty (botany, genetics, or microbiology). Students in the treatment groups worked with a different team instructor each for nine weeks. The criteria used in this study consisted of T-scores from five separate objective tests. The experimental design was a 2x3x5 factorial analysis of variance with intact class sections randomly assigned to experimental or control groups. Variables included two groups, three instructors, and five content areas. Among the conclusions were that academic biology students acquire more biology subject matter knowledge when they are instructed by a team rather than by an individual instructor and that there were significant differences among each of the instructors relative to student achievement in biology. (Author/MH)

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A COMPARATIVE STUDY OF A TEAM VS A NON TEAM TEACHING APPROACH IN HIGH SCHOOL BIOLOGY

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Objectives

One of the instructional formats employed at DuBois Area Senior High School involves a shared or team teaching approach. Students are instructed in four major content areas of biology by three separate instructors. After an Introductory nine week session, students are periodically rotated to each of the instructors who specialize in teaching one of the following areas: Genetics, Botany, or Microbiology.

Every student, by school board regulation, is required to successfully complete one year of biology in order to graduate. With few exceptions, all tenth grade students take biology as sophomores. Each student is placed into one of three levels of biology. Approximately one-third of the sophomore class is tracked into each level.

The basis for placement is the Science sub-score measured by the Stanford Achievement Test given to all students their freshman year. Exceptions to the above placement are not uncommon due to either parental pressure or conflicts in the scheduling of classes.

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The normal procedure is that the lower two-thirds of the sophomore class, based on SAT Science sub-scores, receive the traditional year long instruction from one teacher. The upper third are exposed to three different instructors who subjectively feel the shared approach to be superior for these individuals. It was the intent of this study to provide empirical evidence to test the hypothesis that team teaching in academic biology does not result in greater amounts of learning than non-team teaching in academic biology. Learning variations across instructors, sections, and content specializations were also investigated.

Rationale

Scope of Team Teaching

The scope of team teaching is extremely broad. Discussions and opinionated articles on the topic abound profusely in educational journals and magazines. Surprisingly, the number of empirical studies is disproportionately small in comparison.

A most useful resource for team teaching references is the ERIC microfilm files which includes several lengthy bibliographies, most notedly one by Smith and Fitch (1969) covering the time period from 1950 through 1969.

The concept of team teaching has been perceived differently among individuals. It has been alternatively described as a multi-discipline approach, TV-assisted, large group, individualized, or one of numerous other combinations. One project developed an interactive team teaching environment between structured ITV and the classroom teacher (Shrigley, Alfke, Szabo, and Welliver, 1975). Although there are a number of differences among these various approaches the following two factors remain constant. There is always more than one instructor and some type of formal or informal planning and co-operation is employed.

Administrative Role

It is assumed that any effort by a school district to employ team

teaching is sanctioned by, if not instigated by the administration itself. Robinson (1968) refers to the enthusiasm of school administrators, who open their schools willingly for research, as a possible bias in any study. Peterson's (1964) analysis perceives the administrator's role as one of implementing, encouraging and evaluating. Similar opinions (Borg 1966; Gallessich, et al. 1971; Johnson, et al. 1962) as well as research studies (White 1964; Robinson 1968), often refer to the leader influence of the administration.

Team and Individual Roles

In examining the team teaching staff it becomes evident that some traits are more desirable than others for successful team teaching. For example, Peterson (1964) suggests certain sterotypes should be excluded from the team. These included the loner, the insecure, and the know-it-all.

The need for a team leader was also stressed in several opinions (Korb, 1968; Peterson, 1964) and empirical studies (White, 1964; Robinson, 1968).

The observed methods practiced by instructors in team teaching and those used in traditional classes differ little (Meyer, 1968). In large group instruction there seems to be a tendency to use more audio-visual materials (Robinson, 1968; Hug, 1969; Nesbitt et al., 1960; Madison et al., 1964). The use of highly similar methods and more thoroughly prepared lessons may account for the lack of significant differences between control and treatment groups (white, 1964; Robinson, 1968; Schmitt et al., 1969).

Questionnaires administered after the conclusion of team teaching studies (White 1964; Robinson 1968) indicated most instructors preferred the team approach over the conventional method.

In Robinson's study (1968) of six schools in Rochester, New York, one school showed significant differences in more areas than the others. This school had the largest staff turnover during the three years in which the study was conducted.

The team experience, as a unit, and the experience of each individual instructor, plays an essential role in a team approach. Extending the length of the study helps to control team experience and the Hawthorne effect. Several studies (White 1964; Robinson 1968; Nesbitt et al. 1960) were run consecutively for two to three years. While increasing the time span provides more experience, it also increases the probability of staff turnover. However, one of the assumed advantages of a team approach is the assimilation of new personnel with little change in the overall quality of the program.

Team Teaching and Ability

The interaction of team teaching and ability grouping has been investigated in several studies. Frankel (1967) divided his US History class into quartiles. He found the differences were not significant.

Schlaadt's study (1969) using the criterion of scores on a health knowledge test, reported that only the team taught students improved significantly. However, there is some question as to the significance being the result of intelligence or lower initial scores on the pre-test.

Klausmeier, et al. (1965) reported low ability pupils in English performed better under team teaching but not in social studies. The average pupils performed significantly better in both areas when team taught.

Although empirical data do not totally support the notion that higher ability students perform better in a team setting, the majority of authoritative opinions suggest only gifted or above average pupils be enrolled in such a course.

Summary

Hundreds of articles have been published on the merits of team teaching. Most of them are opinions, lack supporative data, and do not provide insight into the question of the effectiveness of team teaching.

Most of the empirical studies are deficient in information or confuse the reader who lacks a sound background in statistics. The most helpful studies in this instance were those of White (1964) and Robinson (1968). It is the opinion of the author that they represent the best research designs for investigations of team teaching.

The review of the literature suggests the following points:

1) Team teaching success is in part a function of the individual instructors working together under the direction of a strong team leader. The leader may be formally appointed or evolve from within the team itself.

2) Methods used in team teaching and non-team classes vary little. There is a tendency for instructors to be better prepared in the case of large group instruction. The amount of audio-visual material employed has also been shown to increase.

3) Some portion of achievement appears to be related to instructor newness. Team teaching studies appear to be less effective if teacher turnover is high.

4) Studies at all levels from elementary to college indicate that learning attributable to team teaching is not a function of age or sex.

5) Team teaching seems differentially effective for different IQ level student groups. The literature suggests better students be selected for a team approach. This is supported by several studies in which the higher intelligence groups achieve significantly more than the lower groups.

Method

Statement of Problems

The following problems were statistically tested in this study:

1) Do academic students in biology acquire significantly more biology subject matter knowledge in a team teaching approach than in a non-team approach?

2) Do significant differences exist among the instructors relative to student achievement in biology?

3) Do significant differences exist among content areas relative to student achievement in biology?

4) Do significant interactions exist between instructors and groups relative to student achievement in biology?

5) Do significant interactions exist between instructors and content relative to student achievement in biology?

6) Do significant interactions exist between groups and content relative to student achievement in biology?

7) Do significant interactions exist among the interactions of instructors, groups, and content relative to student achievement in biology?

Sample

One hundred and forty-seven (147) sophomore high school students from a rural high school in Central Pennsylvania were placed in six sections of "academic" biology. These students were chosen for academic biology on the basis of their Stanford Achievement Test Science Sub-Score. The cut-off score was set at 7.6, however, several exceptions did occur.

The six sections of academic biology classes were randomly assigned to a control (C) or treatment (T) group. To test the hypothesis of pre-experimental inequality between T and C groups, t-tests which were run between the SAT Science sub-scores of the control and treatment groups were not significant. Results are presented in Table 1.

Insert Table 1 about here

Design

The experimental design was a 2x3x5 factorial with intact class sections randomly assigned to Experimental or Control (Figure 1). Variates included two groups, three instructors and five areas of content. Students lacking a complete set of scores and those which were not sophomores were excluded from the study. In addition, some students were randomly dropped from the study to meet the requirements for equal cell size in the computer program. In all, 27 students were eliminated leaving 20 pupils per section. The five criterion measures were converted to standard score form and analyses of variance were performed using the STPAC ANOV program at The Pennsylvania State University.

	Treatment			Control		
Instructor	1	2	3	1	2	3
Subject 1						
Subject 2						
Subject 3						
Subject 4						
Final						

Figure 1. 2x3x5 Research Design.

Criteria

The criteria used in the study consisted of composite T-scores from five separate objective tests. Subject area tests consisted of forty-five (45) multiple choice questions with four possible responses. The final examination contained forty (40) multiple choice questions.

Four of the tests were composites of questions from the standardized BSCS blue and yellow exams as well as the Nelson Biology Exam forms "E" and "F". Each team member screened an assortment of over four-hundred (400) questions in selecting those he felt were appropriate for the Introduction and his subject area speciality. After sorting out duplications, each instructor chose forty-five (45) items to be used as an achievement measure for his speciality. These tests were administered

the final day of each nine week period. The botany test included eight (8) items which were teacher constructed. This was necessary because no suitable standardized questions could be found to evaluate some of the topics in botany.

An item analysis and a K.R. 20 Reliability were run by a computer on each test (See Table 2). Reliabilities ranged from 0.66 to 0.78.

Insert Table 2 about here

Treatment

The control groups received an entire year of instruction from a single instructor. The treatment (experimental) groups received instruction from all three members of the team. The amount of time spent on each of the four areas of instruction was the same for the control and the experimental. Classes met for one sixty-minute period each day and there were no large group lectures. The textbook used was the BSCS 1st Edition Biological Science: An Inquiry Into Life. The microbiology and botany segments of the course stressed student laboratory work.

The entire team consisted of three male instructors with at least four (4) years of teaching experience. Each instructor was given a control group and taught his speciality to each of the three experimental sections in an attempt to balance the design. Since the instructors had been teaching both rotating and non-rotating classes in the past they had little difficulty in adapting to a full year for the control groups. One of the control sections was taught for a semester by an associate instructor. The first author's teaching speciality was in Microbiology.

The team conferred each day at lunch and wrote down a brief description of the topic and material covered each day in class. These notes were placed on 3x5 cards and at the end of each nine week period the decks were exchanged. They were employed as a guide for instructing the control groups. Each team member was free to delete or expand the outlined topics at his own discretion. Changes centered around the amount of time, depth, and laboratories employed to cover the various topics.

Findings

Analysis for homogenity of variance produced a chi-square value of 0.04. This was found to be significant at the 0.05 level of significance.

The hypothesis of equal variance were further investigated by comparing the mean Science sub-scores of the Stanford Achievement Test (pre-experimental) between the control and the treatment group. The t-test produced a value of 0.938 which is not significant at the 0.05 significance level (See Table 1). Based on the pre-experimental t-test

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Insert Table 1 about here

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results and the assumption that analysis of variance is robust to unequal population variances, it is assumed the results of the analysis are not due to anything other than the treatment.

The analysis of variance summary table (Table 3) contains data which indicates significant differences in three of the seven hypotheses tested.

Insert Table 3 about here

Hypothesis 1

The hypothesis that there is no significant difference in biology subject matter knowledge between the control and treatment groups, was rejected in favor of the treatment group ($F = 15.8$; $p < .01$). Table 4 lists the treatment group mean scores for more meaningful comparison.

Insert Table 4 about here

Hypothesis 2

The second hypothesis, that there are no significant differences among the teachers relative to student achievement in biology, was also rejected ($F = 5.6$; $p < .01$). A further analysis was conducted utilizing the t-test for the means of each teacher (See Table 4). In all three cases there were significant differences (See Table 5).

Insert Table 5 about here

Hypothesis 4

There are no significant interactions between teachers and groups relative to student achievement in biology. This hypothesis was rejected ($F = 6.4$; $p < .01$). Multiple t-tests conducted between the means of the instructors and their groups showed several instances of significance (See Table 6).

Insert Table 6 about here

The following hypotheses were not found to be significant:

Hypothesis 3: There are no significant differences among content areas relative to student achievement in biology.

Hypothesis 5: There are no significant interactions between instructors and content relative to student achievement in biology.

Hypothesis 6: There are no significant interactions between group and content relative to student achievement in biology.

Hypothesis 7: There are no significant interactions among the instructors, groups, and content relative to student achievement in biology.

Conclusions

From the analysis the following seven conclusions about this study were drawn:

1) Academic biology students acquired more biology subject matter knowledge when they are instructed by a team rather than a single instructor.

2) There were significant differences among each of the instructors relative to student achievement in biology.

3) Significant interactions were found to exist between the instructors and their groups.

4) There appeared to be no significant differences among content areas relative to student achievement in biology.

5) No significant interactions were found between instructors and the areas of content.

6) There were no significant interactions between groups and content.

7) Finally, no significant interactions occurred among instructors, groups, and content relative to student achievement in biology.

The findings of this study differ from those of White (1964) and Robinson (1968). In both of their studies, team teaching did not prove to be significantly different from non-team instruction. However, there are two major differences between the studies of White and Robinson and this study.

First, there is the manner in which the samples were selected. White and Robinson assigned students randomly regardless of their academic standing. In this study only students ranked in the upper third of their class based on SAT Science sub-scores were selected. A great amount of authoritative support for selecting better students for the team approach is found in the literature. Since lower ability students were not involved in the present study, the data do not shed any light on the question of ability levels.

The second difference to consider is the method in which the team presented material. The studies of White and Robinson employed large group lectures followed by small group recitation periods. The treatment groups were a small number of large group lectures by other team members. In the present study, there were no large group lectures. Students rotated and spent every day of the nine weeks receiving instruction from a single team memeber in a class of not more than twenty-eight (28) students.

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Table 1

t-Test Comparison of the Mean SAT Science Sub-Scores of the Control and Treatment Group

Control			Treatment		
11.8	8.3	9.6	11.8	10.2	9.8
11.0	10.2	10.4	8.0	11.9	9.6
5.6	5.0	12.4	9.6	7.6	10.8
10.2	10.8	7.6	8.5	8.0	10.8
11.2	9.8	10.8	6.2	11.4	10.2
8.3	9.0	11.2	11.4	10.8	6.5
11.7	9.8	11.2	12.2	7.6	11.9
11.6	12.3	10.0	8.5	11.4	11.7
8.0	11.4	10.6	10.0	11.6	7.2
9.8	11.0	11.0	9.0	9.6	9.6
9.8	8.0	10.4	11.2	11.4	9.0
11.6	10.4	5.5	9.8	10.2	9.6
10.0	8.5	9.0	10.0	11.6	11.8
6.5	10.2	10.2	6.3	10.4	7.6
8.0	9.6	10.6	11.4	9.0	12.3
10.6	9.6	9.0	10.4	9.6	10.2
9.0	9.6	10.6	10.6	8.0	8.3
10.0	9.8	6.7	9.0	8.0	10.8
11.7	5.4	6.7	6.3	5.0	9.6
9.6	6.7	9.6	7.6	7.6	11.0

$\bar{X}_1 = 9.55$ $\qquad$ $\bar{X}_2 = 9.70$

$(X_i - \bar{X}_1)^2 = 187.1$ $\qquad$ $(X_i - \bar{X}_2)^2 = 183.4$

$$t = \frac{9.7 - 9.55}{\sqrt{\frac{187.1 + 183.4}{14160}}} = 0.938$$

Table 2

Information Based on Item Analysis
of the Five Test Criteria

TEST NAME	MEAN	STANDARD DEVIATION	MEAN DIFFICULTY OF ITEMS	K.R. 20 RELIABILITY
INTRODUCTION	28.9	5.9	0.64	0.78
BOTANY	26.3	5.7	0.59	0.75
MICROBIOLOGY	23.9	5.7	0.53	0.72
GENETICS	21.8	5.1	0.48	0.66
FINAL	25.5	5.4	0.63	0.75

Table 3

Summary of the Analysis of Variance

SOURCE	SUMS OF SQUARES	DF	MEAN SQUARES	F-RATIO
1 Instructors	1087	2	543	5.6**
2 Group	1552	1	1552	15.8**
3 Content	88	4	22	0.2
12	1246	2	623	6.4**
13	962	8	120	1.2
23	273	4	68	0.7
123	923	8	115	1.1
ERROR	55818	570	97	

** $p<0.01$

Table 4

Mean Scores for Significant Factors

INSTRUCTOR	$\bar{X}$	GROUP	$\bar{X}$	INSTRUCTOR/GROUP		$\bar{X}$
1	51.5	1 (T)	51.4	1	1	51.1
2	48.2	2 (C)	48.2	2	1	50.9
3	49.7			3	1	52.3
				1	2	52.0
				2	2	45.6
				3	2	47.1

Table 5

Calculated t-Test Values Among Instructor Means

INSTRUCTORS	VALUE
1 : 2	6.6**
1 : 3	3.7**
2 : 3	2.9**

** $p<0.01$

Table 6

Summary of t-Test Between the Means of Instructors and Their Groups

INSTRUCTOR,	GROUP	INSTRUCTOR,	GROUP	t-VALUE
1	1	2	1	0.227
1	1	3	1	0.983
1	1	1	2	0.843
1	1	2	2	5.60 **
1	1	3	2	4.04 **
2	1	3	1	1.42
2	1	1	2	1.07
2	1	2	2	5.32 **
2	1	3	2	3.81 **
3	1	1	2	0.352
3	1	2	2	6.74 **
3	1	3	2	5.25 **

** $p<0.01$